Deconstruction Training Manual

Waste Management Reuse and Recycling at Mather Field

July 2001

California Environmental Protection Agency
Integrated Waste Management Board

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[*] This document prepared by ConSol.

Section 1: Introduction

Deconstruction materials at Mather Field military housing project.

Each year, as many as 100,000 residential buildings are demolished in the United States. This represents more than 8 million tons of wood, plaster and drywall, metals, masonry, and other building materials, most of which will end up in local landfills.

Typically, when a building reaches the end of its useful life, heavy equipment is used to demolish the structure. All parts of the structure are rendered into rubble—a varied mix of wood, masonry, metals, and other materials. In some cases, particularly with large concrete and steel buildings, raw materials may be processed and recycled, but for most light-frame residential buildings, demolition waste ends up in either a municipal or a construction and demolition landfill.

Deconstruction is the selective dismantling or removal of materials from buildings before, or instead of, demolition. It is possible to salvage building components, keeping materials of higher value for reuse. Wood flooring, raised panel doors, ornate interior and exterior trim, electrical and plumbing fixtures, and framing and bricks can have salvage value of up to 75 percent of the items' original value.

The goal of agencies, businesses, and individuals promoting deconstruction in California is that it will grow as a viable industry and reduce the amount of construction and demolition debris that makes its way into California's waste stream. Such waste currently accounts for as much as 30 percent of the waste stream. The Integrated Waste Management Board, the state's primary recycling agency, works in partnership with contractors, builders, engineers, architects, and local governments to encourage the concept of deconstruction as a means of reusing and recycling construction materials.

Contents of This Manual

This manual is composed of four sections with three appendices. Each section discusses a variety of waste management reuse and recycling topics and is summarized below.

Section 1—Introduction

The current section introduces the concept of deconstruction and briefly outlines the manual's contents. The section also discusses the deconstruction training that took place at the housing site for Mather Field, (site of the former Mather Air Force Base in Sacramento, California, that was closed in 1988).

Section 2—Deconstruction Versus Demolition

Section 2 discusses advantages and challenges with deconstruction, markets for salvaged materials, deconstruction time constraints, permit requirements, and disincentives to deconstruction.

Section 3—Deconstruction Safety

Section 3 discusses the California Occupational Safety and Health Administration (CAL/OSHA) program, fall protection, and forklift operation. The section also discusses hazardous materials, asbestos and lead awareness, and asbestos awareness training.

Section 4—The Deconstruction Process

Section 4 covers conducting a building survey and developing an action plan; tools and equipment used in deconstruction; deconstruction of building components, and de-nailing and banding materials.

Appendix A—Fall Protection

Appendix A provides the "Fall Protection Equipment Inspection Form" and the "Hazard Evaluation/Code of Safe Practices for General Work Areas and Specific Job Safety Classes" forms, mentioned in Section 3.

Appendix B—Forklift Operation

Appendix B provides the "Operating Rules for Industrial Trucks" and the "Forklift Pre-Operation Checklist" form, mentioned in Section 3.

Appendix C—Building Materials Inventory

Appendix C provides the "Building Materials Inventory Form," discussed in Section 4.

Mather Field Military Housing Deconstruction

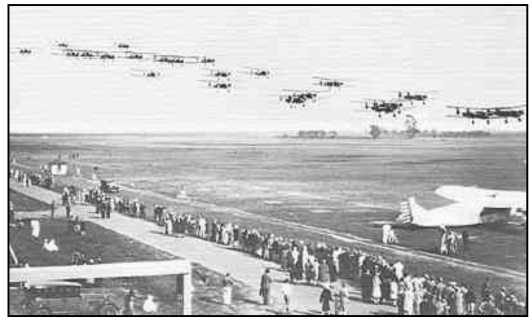
The Mather Field military housing deconstruction project was a pilot project involving deconstruction of six homes located at the former Mather Air Force Base housing site. The majority of the homes in the military housing complex had already been demolished to make room for 1,271 new homes at Independence, a master planned community being developed by the home builder company of Kaufman and Broad.

Roof dismantling of military housing units.

The Sacramento Housing and Redevelopment Agency (SHRA) provided workers, and project funding was from a California Integrated Waste Management Board (CIWMB) grant. The grant made possible the training of 30 low-income individuals from the Sacramento Housing and Redevelopment Agency's apprenticeship construction training program. Beyond Waste Inc., based in Sonoma, California, and one of the pioneer companies in this relatively new field of deconstruction, provided the training. Since the emergence of deconstruction as a new market offers a large opportunity as a source of new jobs, training in this area should prove beneficial. This manual has been developed to document the training given to the SHRA apprentices.

The pilot project included setting up an area at the site for resale of materials salvaged during the deconstruction training.

Mather Field History



Airfield and pilot training school at Mather Field, circa 1930.

Mather Field was established in 1918 as an airfield and pilot training school. It was named for Carl Mather, a World War I pilot and war hero.

Following World War I, the base was used intermittently to support small military units. During World War II, Mather Field was used for pilot and navigator training, as well as observer and bombardier personnel training.

In 1958, the Strategic Air Command B-52 squadron was assigned to Mather (which by that time was officially known as “Mather Air Force Base”). Through the 1950's, 1960's, 1970's, and 1980s, Mather continued to be a center for training of military personnel. By 1990, the primary mission of Mather was to provide all formal long-range and over-water Air Force navigator training.

The base historically operated its own housing, education, hospital, commercial, and recreational facilities, as well as the operational airfield. The majority of on-base development occurred from the 1940s through the 1960s. Expansion and improvements continued into the 1980s, but ceased in 1988 after the closure of Mather was announced.

Following the base closure announcement, the Sacramento County Board of Supervisors initiated reuse-planning activities with the appointment of the Sacramento Area Commission on Mather Conversion. A major element of the various recommended reuse plans included retention of aviation use. In the fall of 1991, the Board of Supervisors endorsed a comprehensive reuse plan and forwarded the plan to the Air Force. In March 1993, the Air Force issued a Record of Decision for the disposal of the base.

Mather aviation facilities were subsequently transitioned to Sacramento County. On May 5, 1995, Mather Airport officially opened as a civilian airport. The airport area, including runways and aprons, consists of approximately 2,875 acres. In September 1995 Mather Regional Park was established. The park encompasses approximately 1,432 acres on the east side of the property, which includes an 18-hole championship golf course and a potential for a variety of recreation opportunities.

On July 10, 1998, the Air Force accepted the Sacramento Housing and Redevelopment Authority’s (SHRA) offer to purchase the Mather Field housing site property, and escrow closed in September 1998.

As part of a public-private partnership, SHRA turned the property over to Lewis Homes Management Corporation[†] for redevelopment under a Disposition and Development Agreement. This agreement set forth the affordability requirements and performance standards for redevelopment of the Mather community. Abatement and removal of the military housing units began in the fall of 1998.

In the fall of 1999, SHRA orchestrated the deconstruction pilot project on six of the homes, and new houses were available on the market by summer 2000.

[†] In January 1999 Lewis Homes merged with Kaufman and Broad.

Section 2: Deconstruction Versus Demolition

Instead of crushing and burying valuable building materials, a deconstruction process not only salvages the most readily available components, but it also extracts additional materials such as oak flooring, oak stair treads, and structural timbers.

Wood reclamation from deconstruction (foreground) versus demolition (background) of military housing at Mather Field.

Deconstruction means “breaking down” building components to recycle or reuse them, not destroying them. It means preserving material, not wasting it.

It is possible to salvage building components, keeping materials of higher value for reuse. Wood flooring, raised panel doors, ornate interior and exterior trim, electrical and plumbing fixtures, even framing and bricks can have salvage value of up to 75 percent of the item’s original value. Add to this value the avoided disposal costs, and a question arises: Can relatively low-skilled deconstruction laborers dismantle a building more cost-effectively than heavy equipment can demolish it?

Advantages

Cost Savings

Preliminary research for a pilot project by the U.S. Environmental Protection Agency and the National Association of Home Builders (NAHB) Research Center (developed with the Baltimore Development Corporation and the Housing Authority of Baltimore) indicates deconstruction may cost 30 to 50 percent less than straight demolition. While labor costs can be higher due to the nature of the work, they are offset by lower equipment costs. Because deconstruction does not require as much heavy equipment but rather relies primarily on hand tools and small machinery, equipment rental costs are lower.

Items removed through deconstruction can be reused in the construction of new developments or sold to a salvaging company. Research shows that the market value for salvaged material is greater when deconstruction occurs instead of demolition, because of the care taken in removing materials. Money made through salvaging can be used to offset other redevelopment costs.

Lastly, disposal costs are lower with deconstruction because the process reduces the amount of waste produced by up to 75 percent.

Job Creation

Many urban revitalization projects involving demolition are underway across the nation in places where a large pool of unemployed workers with minimal skills is available.

Deconstruction requires work crews who are trained to extract salvageable materials from buildings slated for demolition. Training in this process provides new employment opportunities for a minimally skilled work force. In addition, small businesses could be created to handle the salvaged material that would enable businesses to link a deconstruction project to economic development and job training efforts.

Recyclable/Reusable Materials and Preservation of the Environment

The environmental benefits of deconstruction should not be overlooked. The solid waste problem in many localities is so severe that landfills are at capacity. Jurisdictions are now developing incentive programs to meet solid waste reduction goals. One focus of these programs may well be the construction industry, as studies indicate that 26 percent of the material in landfills is building-related.

Deconstruction reduces the amount of building related waste produced during site clearance, thus contributing to waste reduction efforts. In addition, every foot of timber saved and every metal fitting salvaged translates into conservation of natural resources, a worthwhile goal in a time and atmosphere in which our actions can threaten and damage the environment.

Deconstruction results in significantly greater protection to the local site, including the soil and vegetation. This process also creates less dust and noise than demolition.

Challenges

Modern materials such as plywood and composite boards are difficult to remove from structures, and new building techniques such as gluing floorboards and using high-tech fasteners inhibit deconstruction. Thus, buildings constructed before 1950 should ideally be targeted for deconstruction.

Asbestos-containing materials are another problem deconstructionists may encounter in buildings constructed or renovated after 1900 or in buildings that have been renovated. Used in more than 3,000 building products, asbestos may be found in pipe, duct, wall and ceiling insulation, ceiling tiles, roofing, siding, vinyl sheet flooring, wallboard and mud joint compound, plaster, and window caulking. Proper removal of asbestos-containing materials requires special equipment and training.

Because deconstruction requires more time and care than demolition, project labor costs can be higher. One way to minimize labor costs is to recruit volunteers. People who are willing to deconstruct buildings in exchange for materials they want from the site enable the project manager to avoid having to locate markets for the salvaged material. Volunteer laborers can also help organizations (such as Habitat for Humanity) collect building materials for reuse and either give them away or sell them at a low cost for a charitable purpose.

Markets for Salvage Materials

There are many factors that could limit potential demand for building materials acquired through deconstruction, including the following:

- Lack of public and/or contractor awareness about the availability of salvaged materials.
- Lack of awareness of the significant price difference between new materials and salvaged materials.
- The “hit or miss” problem of not being able to find a salvaged material when needed, or enough of a particular salvaged material to complete the project.

- Lack of awareness about the environmental benefits of using salvaged materials.
- Perceptions that salvaged materials are inferior.

However, deconstruction is now recognized as an important field because of a new appreciation for the shortage of beautiful, old building material and the need to conserve existing resources and landfill space. One of the most valuable materials found in old buildings is virgin heart lumber, which, when sanded down and refinished, gives off a light and texture that cannot be found in wood taken from trees that are grown and harvested today. Architects can use this wood and other reclaimed material creatively in new construction. This material is also valuable to remodelers and to historic preservationists restoring old buildings.

Much of the wood recovered through deconstruction is re-milled for wood flooring, and the demand is generally very consistent. Deconstructionists usually salvage 90 to 100 percent of the floor of a building, and the sale of the flooring will often cover the cost of deconstructing the building, including labor and clean-up costs.

Time Constraints

Deconstruction in almost all cases requires significantly more time than demolition. Building removal is generally done under very tight time constraints. The long process of getting demolition permits often cuts into the time needed to deconstruct a building; once a permit is secured, developers are under pressure to demolish the building as soon as possible to make up for financial losses incurred while waiting for a permit. Thus, there is more financial pressure to clear the site quickly and further disincentive to do deconstruction. For a property owner with plans to redevelop after building removal, time is money.

Permits

Many (but not all) local jurisdictions require demolition permits or formal notification of intent to remove a building. Approval of the demolition permit will often be linked to disconnection of electrical power, capping of all gas and sewer lines, and abatement of hazardous materials with action levels of lead and asbestos. In general, there is no difference between the procedures required to obtain a permit for demolition and those required to obtain one for deconstruction.

Addressing Disincentives to Deconstruction

Future efforts should focus on addressing disincentives for deconstruction. One disincentive may be the low landfill tipping fee for construction and demolition debris. A possible solution is support for salvaged-materials collection centers that provide incentives for contractors to seek alternatives to demolishing structures and disposing of debris.

Other disincentives to deconstruction include timing problems. After waiting a lengthy period of time for a demolition permit, contractors face financial pressure to demolish the structure quickly and proceed with redevelopment in order to recoup some of the money lost while waiting for the permit. The longer period of time required for many deconstruction projects (compared to demolition projects) provides further disincentive. Streamlining the permit process, especially in regard to deconstruction projects, could make deconstruction of a project more feasible.

Section 3: Deconstruction Safety

Deconstruction site safety signage.

Fall protection, maintenance of structural integrity, and fire prevention are issues that must be considered during deconstruction, but that are often less important during conventional demolition. Hazardous materials such as asbestos and lead can also be an issue for deconstruction safety.

Although no formal procedures or standards exist for structural disassembly, the sequence must be such that collapse of the structure is prevented, and all workers must be aware of critical supports, both existing and temporary. Fire can also be a concern on any job site but is even more important when building materials critical to the bottom-line of the project are stored on site.

Site Security

The focus of site security for a demolition project is the safety of workers and the general public. In a deconstruction project, there is also the added importance of protecting the salvaged materials. In most cases, the value of the salvaged material has been enhanced through disassembly, cleaning, and organized storage—thus making the materials more vulnerable to theft. Those responsible for site security should consider installing a perimeter fence with a locked gate.

California Occupational Safety and Health Administration (Cal/OSHA[‡])

Overview of Cal/OSHA

California administers its own workplace safety and health program according to provisions of the Federal Occupational Safety and Health Act of 1970. The act permits a state to manage its own occupational safety and health program if it meets certain federal requirements. Cal/OSHA, the California program approved by the federal Occupational Safety and Health Administration (OSHA), is also monitored by and receives part of its funding from the federal agency.

The Department of Industrial Relations heads the State's occupational safety and health program and has administered the Cal/OSHA program since 1973, when California's plan was approved. Major units include the following:

- Division of Occupational Safety and Health (DOSH)—enforces worker safety and health standards and regulations.

[‡] When referring to either "Cal/OSHA" (State) or "OSHA," (federal) the acronym "OSHA" represents both "Occupational Safety and Health Administration" and "Occupational Safety and Health Act."

- Cal/OSHA Consultation Service (within DOSH)—offers free training and consultation to assist both employers and their employees in complying with workplace safety and health regulations.
- Occupational Safety and Health Standards Board—adopts, amends, and repeals the standards and regulations.
- Occupational Safety and Health Appeals Board—hears appeals regarding Cal/OSHA enforcement actions.

Other Cal/OSHA elements are in the following State divisions and resource program:

- Division of Labor Standards Enforcement (DLSE), within the Department of Industrial Relations—protects employees who report hazardous working conditions from being discriminated against in the workplace.
- Division of Labor Statistics and Research (DLSR), within the Department of Industrial Relations—publishes reports on occupational injuries and illnesses.
- Hazard Evaluation System and Information Service (HESIS)—administered by the Department of Industrial Relations and Department of Health Services as an information resource and early warning system.

Cal/OSHA covers virtually all workers in the state, including those employed by State and local government. Cal/OSHA does not cover federal employees, offshore maritime workers, or domestic service workers in private households. Cal/OSHA standards are contained in the California Code of Regulations, Title 8, Industrial Relations.

The following DOSH responsibilities are mandated by State law only and do not receive federal funding. They include:

- Certification of employers and consultants involved in asbestos-related work.
- Issuing permits for operation of elevators and aerial passenger tramways.
- Issuing permits for portable amusement rides, including bungee jumping.
- Inspecting mines, tanks, and boilers.
- Certification of loss control services of workers' compensation carriers.

State reforms in 1993 regarding workers’ compensation laws called for prevention of workplace injuries and illnesses as a first line of defense against soaring workers' compensation claims. The reforms mandate targeted inspections and consultations, putting primary emphasis on high-hazard industries and employers who show the highest incidence of preventable workplace injuries and illnesses.

Fall Protection

Safety harnesses on roof dismantling crew members using board puller to salvage wood boards.

Safety is not only an issue with Cal/OSHA or with job site managers. Keeping safe is a moral obligation. All workers have an obligation to their families to give themselves every opportunity when it comes to safety in the workplace.

A typical day in the construction industry in the United States will see one to three workers die from falls in the workplace. Falls are the leading cause of death and injury in the construction industry.

Regarding fall protection, the California Code of Regulations states:

"Approved personal fall arrest, personal fall restraint or positioning systems shall be worn by those employees whose work exposes them to falling in excess of 7½ feet from the perimeter of a structure, unprotected sides and edges, leading edges, through shaftways and openings, sloped roof surfaces steeper than 7:12, or other sloped surfaces steeper than 40 degrees not otherwise adequately protected under the provisions of these Orders."[§]

Cal/OSHA requires employers to train employees who might be exposed to fall hazards. Training includes but, is not limited to:

- Nature of fall hazards in the workplace
- Fall protection equipment procedures
- Rescue procedures

Nature of Fall Hazards in the Workplace

Each deconstruction project will offer different challenges with a diversity of new and unique hazards that must be identified and dealt with. The identification of these hazards should begin with the initial walk-through. Of course, other hazards will arise during the actual deconstruction process, so there must be a continual effort to identify these hazards through the course of the deconstruction process. Communication of these hazards is vital to worker safety. OSHA requires that a safety meeting occur at least once every 10 days. When a hazard has been identified, there must be a code of safe practice or safety rule. Appendix A provides the form titled "Hazard Evaluation/Code of Safe Practices for General Work Areas and Specific Job Safety Classes" that can be completed and posted at the job site, then updated as needed. Standard parts of the form are in Table 1.

[§] Title 8, section 1670 (a)

Table 1: Hazard Evaluation/Code of Safe Practices for General Work Areas and Specific Job Safety Classes (standard parts of form—see Appendix A for entire form allowing for insertion of specific job tasks)

Potential Safety/Health Hazards	Code of Safe Practices
Falls due to improper fall protection equipment	Employee will only use fall protection equipment that is approved for the task.
Falls due to improper use of fall protection equipment	Employees will follow all safety rules/guidelines established by the company with respect to the use of fall protection equipment.
Falls due to the use of fall protection equipment that is frayed, distorted, cracked, or cut.	Employees are to inspect all fall protection equipment for damage prior to each use.
Falls due to the use of improper tie-off points	Employees using fall protection equipment must tie-off only at approved points.
Injuries/falls due as a result of slipping on wet surfaces.	Employees will only wear approved footwear and use caution when working on wet surfaces.
Injuries/falls due to slip/trip hazards.	Employees will keep worksite clean and orderly. All equipment will be properly stored when not in use.

Fall Protection Equipment Procedures

Each employee should be trained on the correct procedures for the selection, use, care and inspection of personal fall protection equipment.

Properly Fitted Equipment: It is critical that fall protection equipment be properly fitted. A recommendation is to use the buddy system when fitting the safety harness. It is easier for someone else to spot a problem with a harness than it is for the person putting it on. There are three important conditions to look for in a properly fitted harness:

1. The chest strap should be located 6 to 8 inches below the shoulders.
2. The D ring in the center of the back should be located between the shoulder blades.
3. The leg straps should be snug but not too tight or too loose. You should be able to slip your hands into the leg straps.

Fall Protection Equipment Inspection: Harnesses, body belts, safety straps, and lanyards should be inspected each day before each use to determine that they are safe. Those determined to be unsafe shall immediately be removed from service. Harnesses, body belts, safety straps, and lanyards shall be inspected once every six months by a competent person and the results documented. A competent person is someone who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who had the authorization to take prompt corrective measures to eliminate them.

Table 2: Full-Body Harness/Positioning Belt/Body Belt Inspection

No.	Equipment	Inspection
1	Belts and Straps	Check for frayed edges, broken fibers, pulled stitches, cuts, or chemical damage.
2	D Rings	Check D ring and D ring metal wear pad (if any) for distortion, cracks, breaks, and rough or sharp edges.
3	Attachments of Buckles	Note any unusual wear, frayed or cut fibers, or distortion of buckles/D rings. Check all rivets.
4	Frayed or Broken Strands	Check webbing surface for broken/cut stitches.
5	Tongue or Billet	Inspect for loose, distorted, or broken grommets.
6	Tongue Buckle	Check for distortion or sharp edges.
7	Friction Buckle	Outer bars and center bars must be straight. Check corners and attachment points of the center bar.

Table 3: Lanyard Inspection

No.	Equipment	Inspection
1a	Hardware—Snaps	Inspect for hook and eye distortions, cracks, corrosion, or pitted surfaces. Inspect latch and keeper spring/lock.
1b	Hardware—Thimbles	Edges of thimble must be free of sharp edges, distortion, or cracks.
2	Steel Lanyard	Check for cuts, frayed areas, or unusual wear patterns.
3	Web Lanyards	Check for swelling, discoloration, cracks, and charring from heat/chemical damage.
4	Rope Lanyards	Check for fuzzy, worn, broken, or cut fibers.

Fall Restraint System Setup

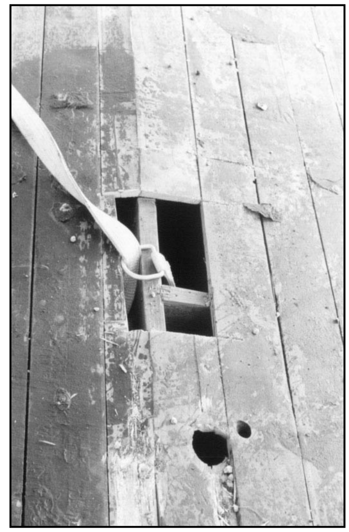
The first step in setting up a fall restraint system is to identify an anchor point for the tie-off adapter. The anchor points used for the deconstruction-training program at Mather Field were the ridge beams or the center beams of the homes.

Once the anchor point has been identified and the tie-off adapter has been set up, the next step is to attach the lifeline. Attach the lifeline by affixing the snap hook to the D ring of the tie-off adapter. Then lay down the lifeline and extend it.

The next step is to set up the rope grab to the lifeline. Make sure the arrow is pointed to the anchor point. Place the lifeline into the cylinder, make sure the holes are aligned, and make sure the safety line is attached to the retaining pin and that it shows through on the opposite side.

Using the buddy system, make sure the snap hook of the lanyard is securely attached to the D ring on the harness. Next, attach the other end of the lanyard to the rope grab.

People using the fall restraint system must be aware at all times of their proximity to the closest leading edge or another type of drop-off, such as a hole in the roof.



Ridge beam anchor point used to tie off the lifeline of a safety harness.

Rescue Procedures

OSHA states that prompt rescue of an employee must be provided for. Prior to start of work, emergency procedures must be identified in a plan or meeting. Following are some suggestions:

- Develop a post-fall recovery plan.
- Plan access route for response reams.
- Inventory useful tools and their location before a fall occurs (ladders, scaffolds, man lifts, hoists, rescue winches).
- Avoid further injuries and falls by providing fall protection for both rescuer and subject.
- Minimize risk and communication problems by limiting the number of well-intentioned rescuers.

Despite the most conscientious precautionary measures, situations develop that do not fit the recovery plan. If immediate help is not available, the victim may face a period of prolonged suspension, which emphasizes the necessity of an adequate fall restraint system.

If a worker does experience a fall, the emergency measures listed below may be activated to protect both the fall victim and intended rescuers. (several steps can be simultaneously employed). In-house fire/rescue staff or local fire/emergency squads should perform these rescue measures.

- Communicate with the subject.
- Establish the level of consciousness and evaluate injuries.
- Comfort and monitor the victim continually.
- Call emergency units (ambulance, fire-rescue, etc.). It's better to have too many rather than too few units at the scene. This also helps deflect criticisms of emergency actions that may arise after the crisis is over.
- Appoint a qualified person (incident commander) to take charge of the operation's overall safety. This person should be able to look at the big picture and find weak points regarding both subject and rescuer safety, and have authority to order changes when needed.
- Evaluate the scene: Can you safely gain access with ladders, man-lifts or hoists? If so, choose rescuers who are moving efficiently, without panic, preferably with first-aid training. Supply them with fall protection. If not, determine the response time for a trained fire/rescue unit. If the response time exceeds 15 minutes, medical attention may become necessary.

Several safe rescue techniques can help both non-injured and injured post-fall victims. They include:

- Belaying: Protecting the rescuer and subject with rope anchoring
- Controlled rope descent
- Use of mechanical systems (lifts, etc.)

Medical Considerations: Evaluate and stabilize the subject before moving. Head, neck, and back injuries can be compounded if a victim is moved incorrectly.

During a lowering rescue, it is most efficient to lower the victim to within three or four feet of the ground and then administer first aid, unless the subject's airway is obstructed.

Forklift and operator.

If the post-fall subject has been suspended in a full-body harness for more than 15 minutes, the rescue team should be aware of the possibility of delayed shock. (While the subject is hanging in the harness, circulation to the legs may be cut-off. Lactic acid and other chemicals begin to build up as blood pools in the legs. During the rescue effort, body weight may be shifted in the harness, causing a sudden release of pressure from the harness straps; blood and chemical build-ups are then allowed to surge through the body, prompting a physical reaction that could lead to delayed shock symptoms. The rescued subject should be placed in a prone position and monitored closely.

Forklift Operation

A forklift is an important machine in deconstruction. The same amount of care must be taken in working with a forklift as in working with any other piece of equipment.

Title 8, section 3664 (a) of the California Code of Regulations states that every employer using industrial trucks must post a set of operating rules, including appropriate rules contained in section 3664. One of these rules is as follows: "Only drivers authorized by the employer and trained in the safe operations of industrial trucks or industrial tow tractors shall be permitted to operate such vehicles. Methods shall be devised to train operators in the safe operation of industrial trucks."[**]

A poster containing operating rules for industrial trucks may be ordered or downloaded through Cal/OSHA's publications page (www.dir.ca.gov/DOSH/puborder.asp).[††]

Because of the many types of forklifts, workers must be certified to drive each forklift they operate. If a worker leaves the current job site and goes to a different project with a different forklift, Cal/OSHA requires that the worker be certified on that forklift.

Forklift Operator Training

Cal/OSHA requires that each forklift be inspected every day before use. Generally, the first person to use the forklift is responsible to inspect the forklift. The forklift operator's report must be filled out daily. A copy of the "Forklift Pre-Operation Checklist" form is in Appendix B.

[**] Title 8, section 3664 (a)(1)
[††] If Internet access is not available, the Cal/OSHA Education Unit at (916) 574-2528 can fax callers a request order form to use in ordering hard copies.

The purpose of a forklift operator training program is to provide employees with guidelines for the safe operation of industrial lift trucks.

1. **Know your forklift.**

- Every day you should check the safety devices on the forklift:

  Horn
  Lights
  Brakes
  Back-up alarm

- In addition, you must know the location and/or safe operation of:

  Mast and tilt lever
  Accelerator
  Brakes
  Forks
  Lights and horn
  Seat belt
  Nameplate
  (The nameplate contains the forklift's maximum-capacity rating. Never lift above the forklift's capacity!)

2. **Drive safely**

- Make your driving motto "Safety first." No matter what the road conditions, follow safe driving procedures.

  Keep the load low
  Follow safe speed limits.
  Avoid sharp turns.
  Keep safe visibility.
  Use your horn.
  Look out for chuckholes.
  Never carry hitchhikers.
  Park safely.
  Watch the slope.
  Leave aisle room.
  Avoid tipping over.
  Don't drive with tall loads.
  Make sharp turns slowly.
  Keep load upgrade.
  Avoid fast speeds.
  Avoid uneven surfaces.

3. Load and unload safely.

- Loading and unloading are prime accident times for you, co-workers, and property. When loading, enter the pallet carefully, capture the load safely, and keep your forks low.

- Unloading poses the most potential for accidents because you have to be alert for more variables. Whether you stack your load on a rack or a truck, use safe driving skills. Be careful and alert, and follow these steps:

Forklift loading empty pallets.

  - Enter the pallet: Keep forks high enough to enter the pallet and as wide apart as possible.
  - Capture the load: Lift and tilt load back so it is secure, and never exceed your forklift's weight limits.
  - Keep forks low: Forks should clear the road by 4 to 6 inches. Raise them higher for ramps or grades.
  - Plan your route: Plan your route so you will be prepared for what is ahead (surfaces, visibility, ramps, and intersections).
  - Turn into position: Turn slowly. Raise the forks into position. Be alert so you do not damage property.
  - Stacking: Raise the load to the right height. Position the load. Tilt the load forward and lower slowly. Withdraw the forks slowly. Back out, looking over your shoulder.

- Co-Worker Safety (to keep a co-worker safe on a platform)

  Use a securely attached safety platform.
  Protect from moving parts with a mast guard.
  Never travel with co-workers on a platform.
  Watch out for overhead obstructions.

- Pedestrian Safety

  Keep a safe distance from loads.
  Stay clear of turning forklifts.
  Be sure the drivers know where you are.

Hazardous Materials

For commercial properties (commercial meaning nonresidential or residential property greater than four units), it is the responsibility of the property owner(s) to make reasonable efforts to identify hazardous materials on the site prior to demolition or deconstruction. Reasonable efforts include a thorough visual, noninvasive inspection of all aspects of the site and structures by individual(s) trained in environmental assessment.

Deconstruction workers in protective gear for removal of potentially hazardous materials.

The most common problems encountered are building materials containing lead paint or asbestos, underground fuel storage tanks, and electrical transformers or their components containing polychlorinated biphenyls (PCB). Although not a requirement, many commercial property owners employ a consulting firm to conduct a Phase I Environmental Site Assessment (ESA) and, if indicated, a subsequent Phase II investigation. While no consulting firm will be willing or able to guarantee the environmental condition of a commercial site, use of a trained inspector following industry standards for environmental assessment, such as those set out in American Society for Testing and Materials (ASTM) standard 1527-94 or 1528-94, is evidence that reasonable efforts were made to identify hazardous materials.

For residential properties of four units or less, there are no formal environmental assessment standards. The materials most likely to be problematic are lead- and asbestos-containing materials.

Lead Awareness

Both EPA and OSHA also have rules governing the management of lead-based paint in buildings. EPA regulations describe the conditions under which lead-based paint building materials must be disposed of as hazardous waste. The language of EPA disposal regulations makes no distinction between a deconstruction and a demolition approach.

OSHA rules identify manual demolition of any material containing lead as an activity that is presumed to require lead exposure worker protection measures, regardless of absolute levels of lead in painted surfaces. While the OSHA rules do not exempt mechanical demolition from proof of worker exposure, there is no presumption of exposure levels that require worker protection measures for mechanical demolition. OSHA has targeted activities that generate large amounts of dust with workers in close proximity.

OSHA worker protection requirements for both lead and asbestos create a clear distinction between the activities of manual deconstruction and conventional mechanical demolition.

Asbestos Awareness

There are two sets of federal regulations involved in the management of asbestos-containing materials (ACM)[‡‡]:

[‡‡] State and local handling and disposal regulations must meet, but can exceed, the requirements of federal regulations—check both State and local regulations in your work area.

- U.S. Environmental Protection Agency (EPA) rules for the handling and disposal of ACM.
- OSHA regulations specifying practices for worker protection.

Deconstruction worker looking for asbestos-containing materials.

The EPA rules for asbestos (National Emission Standard for Hazardous Air Pollutants—NESHAP) contain no language that would require different hauling and disposal procedures for deconstruction and demolition. Most importantly, the EPA does not require the abatement of ACM floor tiles and ACM roofing shingles prior to demolition or deconstruction activity.

There is an asbestos NESHAP residential building exemption that applies to the demolition or renovation of any residential structure of four units or less. EPA has determined that the total amount of asbestos in such residential structures is small enough that NESHAP does not apply.

By contrast, OSHA rules for worker exposure to asbestos could place a greater burden on deconstruction than demolition. There are clear worker protection practices for the manual removal of ACM floor tiles. No such worker protection practices exist for heavy equipment operators performing mechanical demolition.

Asbestos Awareness Training

The following information was provided to the trainees at the Mather deconstruction-training program. The materials were developed and presented by RichMarc Environmental Consultants, Inc.

Background Information on Asbestos

Historical Perspective: The word “asbestos” is derived from a Greek adjective meaning “inextinguishable.” The “miracle mineral,” as the Greeks referred to it, was admired for its soft and pliant properties, as well as its ability to withstand heat. Asbestos was spun and woven into cloth in the same manner as cotton. It was also utilized for wicks in sacred lamps. Romans likewise recognized the properties of asbestos, and it is thought that they cleaned asbestos tablecloths by throwing them into the flames of a fire.

From the time of the Greeks and Romans in the first century until its re-emergence in the 18th century, asbestos received little attention or use. It was not available in large amounts until extensive deposits were discovered in Canada in the 19th century (late 1800’s). Following the discovery, asbestos emerged as an insulating component in thermal insulation for boilers, pipes, and other high temperature applications and as a reinforcement material for a variety of products.

Characteristics of Asbestos: Asbestos is a naturally occurring mineral. It is distinguished from other minerals by the fact that its crystals form long thin fibers. Deposits of asbestos are found throughout the world. The primary sites of commercial production are Canada, the Soviet Union, and South Africa. Asbestos is also mined commercially in the United States.

Asbestos minerals are divided into two groups, serpentine and amphibole. The distinction between groups is based upon the crystalline structure of each group; serpentine minerals have a sheet or layered structure, while amphiboles have a chain-like crystal structure.

Chrysotile, the only mineral in the serpentine group, is the most commonly used type of asbestos and accounts for approximately 95 percent of the asbestos found in buildings in the United States. Chrysotile is commonly known as “white asbestos,” so named for its natural color.

Five types of asbestos are found in the amphibole group. Amosite, the second most likely type to be found in buildings, is often referred to as “brown asbestos” and in its natural state is brown in color.

Crocidolite, “blue asbestos,” is also an amphibole. Crocidolite was used in high temperature insulation applications.

The remaining three types of asbestos in the amphibole group are anthophyllite, tremolite, and actinolite. These are extremely rare and of little commercial value. Occasionally they are found as contaminants in ACMs.

Once extracted from the earth, asbestos-containing rock is crushed, milled (ground) and graded. This produces long, tread-like fibers of material. What actually appears as fiber is an agglomeration of hundreds or thousands of fibers, each of which can be divided even further into microscopic fibrils.

Uses of Asbestos: Asbestos has been used in literally hundreds of products. Collectively, these are frequently referred to as “asbestos-containing materials.” Asbestos gained widespread use because it is plentiful, readily available, and low in cost. Because of its unique properties—it is fire resistant, has high tensile strength, is a poor heat and electric conductor, and is generally impervious to chemical attacks—asbestos proved well-suited for many uses in the construction trades.

One of the most common uses for asbestos has been as a fireproofing material. It was sprayed on steel beams, columns, and decking used in construction of multi-story buildings. This application prevented these structural members from warping or collapsing in the event of a fire. Chrysotile was the most commonly used asbestos constituent in sprayed-on fireproofing. Asbestos comprised 5 to 95 percent of the fireproofing mixture and was used in conjunction with materials such as vermiculite, sand, cellulose fibers, gypsum, and a binder such as calcium carbonate. When combined, these materials are soft and may be fluffy in appearance and to the touch. They vary in color from white to dark gray; occasionally, they have been painted or encapsulated with a clear or colored sealant. The material may be exposed or concealed behind a suspended ceiling. Application to structural members (beam and columns) often resulted in some material being sprayed on walls and ceilings as well. This is referred to as “over spray.”

Asbestos has been added to a variety of building materials to enhance strength. It is found in concrete and concrete-like products. Asbestos-containing cement products generally contain Portland cement, aggregate, and chrysotile fibers. The asbestos content may vary by up to 50 percent by weight, depending on the use of the product. Asbestos cement products have been used as siding and roofing shingles, as wallboard, as corrugated and flat sheets for roofing, cladding and partitions, and as pipes. Asbestos has also been added to asphalt, vinyl, and other materials to make products like roofing felts, exterior siding, floor tile, joint compounds, and adhesives.

Fibers in asbestos cement, asphalt, and vinyl are usually firmly bound in the cement and will be released only if the material is mechanically damaged, for example by drilling, cutting, or sanding. Roofing shingles and siding may also show slow deterioration from weathering.

Asbestos proved valuable as a component of acoustical plaster. The material was applied by trowel or by spraying on ceiling and sometimes walls. It varies in color from white to gray; rarely was it painted, as a noticeable loss of acoustical value occurs.

Similarly as a decorative product, asbestos was mixed with other materials and sprayed on ceilings and walls to produce a soft, textured appearance.

Friable Versus Nonfriable ACM: The EPA and others distinguish between friable and nonfriable forms of ACMs. Friable ACMs contain more than 1 percent asbestos and can be "crumbled or reduced to powder by hand pressure." Other things being equal, friable ACMs are thought to release fibers into the air more readily; however, many types of nonfriable ACMs can also release fibers if disturbed.

Categories of Asbestos-Containing Building Materials

EPA identifies three categories of ACMs used in buildings (known as "asbestos-containing building materials," or ACBMs):

- Surfacing Materials: ACM sprayed or troweled on surfaces (walls, ceilings, and structural members) for acoustical, decorative, or fireproofing purposes. This includes plaster and fireproofing insulation.
- Thermal System Insulation: Insulation used to inhibit heat transfer or prevent condensation on pipes, boilers, tanks, ducts, and various other components of hot and cold water systems and heating, ventilation, and air conditioning (HVAC) systems. This includes pipe lagging, pipe wrap, block batt, and blanket insulation, cements and "muds," and a variety of other products, such as gaskets and ropes.
- Miscellaneous Materials: Other largely nonfriable products and materials such as floor tile, ceiling tile, roofing felt, concrete pipe, outdoor siding, and fabrics.

While it is often possible to "suspect" that a material or product is or contains asbestos by visual determination, actual determinations can only be made by instrumental analysis. The EPA requires that the asbestos content of suspected materials be determined by collecting bulk samples and analyzing them by polarized light microscopy (PLM). The PLM technique determines both the percent and type of asbestos in the bulk material.

However, some of these materials do not have to be inspected and inventoried under the Asbestos Hazard Emergency Response Act (AHERA) Rule. Asbestos-containing building materials as defined by the rule, do not include materials installed outside a building (e.g., roofing felt and siding) and all fabric materials.

Potential Health Effects Related to Asbestos Exposure

Evidence of Health Risks: To understand the health risks associated with a substance such as asbestos, scientists evaluate data compiled from clinical, epidemiological, and laboratory studies. Clinical data ordinarily provide the first indication that a substance may have adverse effects on the body. Physicians observe a pattern of symptoms, or the presence of a disease that appears to be linked with a particular activity or exposure to a particular substance. Such observations lead to a hypothesis that the activity or substance caused the symptoms of the observed disease. Epidemiologists will then undertake an investigation to attempt to confirm the hypothesis. If their investigation substantiates an association between the symptoms, or disease, and the activity, or substance, laboratory studies are undertaken. Should animal response to the substance produce effects similar to that observed in humans, the case for an association is strengthened.

Most of the information on the health effects of exposure to asbestos has been derived from studies of workers exposed to asbestos in the course of their occupation. Asbestos fiber concentrations for such workers are many orders higher than those encountered by the general public, or by most workers in buildings with ACMs. Because their exposure was much higher, asbestos workers will have a much higher incidence of asbestos-related diseases than people who live or work in buildings with ACMs. This is known as the dose-response effect. However, people in buildings with ACMs are still likely to experience higher risks than the public at large. Unfortunately, the available data does not allow us to reliably estimate the actual risk.

Because asbestos fibers appear to be ubiquitous, virtually everyone is exposed to some extent. During autopsy, asbestos fibers have been detected in the lungs of most urban residents. Exposure of the general public is troublesome because we are talking about a large population, which includes unhealthy as well as healthy persons. Moreover, exposure may begin during childhood, leaving a long period for the manifestation of asbestos related disease. Furthermore; asbestos may enhance the carcinogenic effects of other materials. Any additional exposure to asbestos caused by living or working in buildings with ACMs should thus be avoided.

Despite epidemiological studies of workers and laboratory studies of animals, questions remain about which properties of asbestos are responsible for the adverse health effects. It is not known whether the particular properties that produce one disease (for example, lung cancer) are the same as those that produce other diseases, such as asbestosis. Exposure conditions most likely to lead to adverse health effects have not been positively identified. Some characteristics that appear to be important are the physical size of fibers (long, thin fibers seem to be the most toxic) and their durability. The variation in chemical composition among different types of asbestos does not appear to be as important as differences in physical properties. However, the EPA believes that current evidence is not sufficient to say that one type is any more toxic than another.

Some natural substances other than asbestos seem to have health effects similar to those of asbestos. For example, erionite, a fibrous form of a mineral called “zeolite,” induces a condition called “mesothelioma” in test animals. Persons living in central Turkey, where erionite is found, experience a higher than expected incidence of several diseases associated with asbestos. These include mesothelioma, previously believed to be caused exclusively by asbestos.

Exposure to manmade mineral fibers, such as fibrous glass and ceramic materials, is relatively recent. Occupational exposure levels have not been as high as asbestos exposure. However, some epidemiological data do suggest that diseases of the respiratory tract, such as pulmonary fibrosis and lung cancer, may result from long-term exposure to these fibers if the fibers are thin. Fibrous glass used for thermal insulation does not appear to be a problem.

The Respiratory System: To be a significant health concern, asbestos fibers must be inhaled. An understanding of the mechanics of the respiratory system will aid in appreciating the potential for exposure and the resulting health effects. Every cell in the body needs a constant supply of oxygen. The respiratory system meets this need by bringing oxygen to the bloodstream, which delivers it to each cell and carries away carbon dioxide. The lungs are the focal point of the respiratory system, which also includes the respiratory tract, the channel by which air flows into and out of the lungs.

When inhaled air passes through the nose, moisture and tiny hairs filter dust. The air then passes down the throat, where air is also humidified. Air continues into the trachea, a tube supported by rings of cartilage. Just above the heart, the trachea divides into two bronchi. Each bronchus leads into a lung and subdivides into bronchioles and smaller air tubes, giving the appearance of an upside down tree. The tiniest tubes end in globular air sacs, or alveoli.

The actual exchange of gases, respiration, takes place in the alveoli. There, blood vessels only one cell thick allow oxygen and carbon dioxide to trade places. The carbon dioxide is exhaled back up the respiratory tract; and the blood picks up fresh oxygen and transports it throughout the body.

The lungs (cone-shaped, balloon-like, elasticized tissues) are located on either side of the chest. Each lung is encased by a double layer of membrane, or pleura. One layer is attached to the lung, the other to the rib cage. Space and fluid between the two layers enable the lungs to expand and contract in the chest cavity without friction. To visualize this association, think of two panes of glass with a drop of water between them. The pieces of glass, like the linings, slide easily across each other, but are difficult to pull apart. When we breathe in, pulling the ribs up and out, this expands the chest cavity creating a vacuum between the lining that expands the lungs and sucks in air. When breathing out, the diaphragm and rib cage muscles relax, the ribs fall in and down, and the lungs contract and push out the carbon dioxide and unused oxygen.

The respiratory system is sensitive to bacteria, viruses, and many airborne particles that can be inhaled. Reactions to these irritants can disrupt the functioning of the system resulting in many ailments including the common cold, hay fever, sinusitis, sore throat, acute or chronic bronchitis, emphysema, and lung cancer.

The body has several mechanisms by which it filters the air it breathes. The tiny hairs in the nose filter out dust and airborne particles. Like the nose, the trachea and the bronchi are lined with small fine “hairs” called “cilia.” Together with mucous secreted by cells lining the airways, cilia trap particles and help prevent respiratory infections. The cilia beat in an upward direction moving foreign particles up to the back of the mouth; from there they are expelled or swallowed. Viruses and bacteria are also attacked by enzymes called “lysozymes” in the mucous cells. Microbes that slip through are usually handled by white blood cells called phagocytes that envelop and digest these invaders in the lungs.

Cigarette smoking temporarily paralyzes the cilia. If smoking continues long enough, the cilia wither and die, and the body does not replace them. The efficiency of the cilia is replaced by the smoker’s inefficient cough, which attempts to rid the respiratory tract of foreign particles and excess mucus.

Dirty, contaminated air presents the greatest challenge to the respiratory system. Some of the particles entering the airways reach the alveoli. When this occurs, white blood cells called “macrophages” attempt to engulf and digest the particles. In the case of asbestos, we are dealing with a mineral fiber, a substance that macrophages can often not successfully attack. As a means of secondary defense, the macrophages deposit a coating on the fibers, which are then deposited in the smaller passages. Here they clog and actually scar the tissues. The walls of the alveoli lose their elasticity and useful function in respiration. Coated asbestos fibers (“asbestos bodies”) are often seen at autopsy.

Diseases Associated With Asbestos Exposure: The Greeks and Romans observed the adverse health effects of asbestos in the first century. They noted a breathing problem in slaves weaving asbestos cloth. Modern knowledge linking asbestos and a lung disease called “asbestosis” dates to 1900. Autopsy reports from 1938 to 1949 indicated a large number of persons who died with asbestosis also had lung cancer. In the 1960’s the link between asbestos and a rare cancer, mesothelioma, was established. These three diseases are discussed below.

Asbestosis is a scarring (fibrosis) of the lung. The scarring impairs the elasticity of the lung tissue and hampers its ability to exchange gases, causing inadequate oxygen intake to the blood. The disease restricts breathing, which leads to decreased lung volume, and it also increases resistance in the airways. Asbestosis is a slowly progressive disease with a latency period of 15 to 30 years.

Asbestosis may progress even after exposure to asbestos has ceased. The earliest symptom of asbestosis is often coughing. As the disease progresses, shortness of breath upon exertion is experienced. Changes in lung function, rales (crackling sounds in the lower half of the lung), and clubbed fingers are disease markers. As the disease advances, x-rays of the chest help demonstrate the incidence of fibrosis, although a lung biopsy provides the only definitive diagnosis. Asbestosis can only be observed with relatively high doses of exposure. While there is no cure for asbestosis, anyone suffering with the disease should be removed from further exposure.

Lung cancer is a malignant tumor of the bronchi covering. The tumor grows through surrounding tissue invading and often obstructing the air passages. The earliest symptom is often a persistent cough; a physical exam may attribute the symptoms to chronic bronchitis. Chest x-rays sometimes show shadows that indicate tumors and enlarged lymph nodes. However, the definitive diagnosis of lung cancer is based upon microscopic examination of lung tissue. The time between exposure to asbestos and the occurrence of lung cancer is 20 to 30 years. Although there are many causes of lung cancer, a clear increase in risk has been found among people who work with asbestos. Moreover, there is no threshold or limit of exposure below which the risk of lung cancer is not increased.

Mesothelioma is a cancer of the mesothelium, the lining of the chest or of the abdominal wall. It is considered to be a marker disease for asbestos exposure. Early stages are associated with few symptoms. By the time it is diagnosed, it is almost always fatal. Effective therapy does not exist. The fact that family members of asbestos-exposed workers have developed mesothelioma suggests there is no exposure threshold for mesothelioma. Presumably, cleaning the clothes of the exposed worker exposed family members to asbestos dust and led to the disease. Similar to other asbestos related diseases, mesothelioma has an extended latency period of 30 to 40 years.

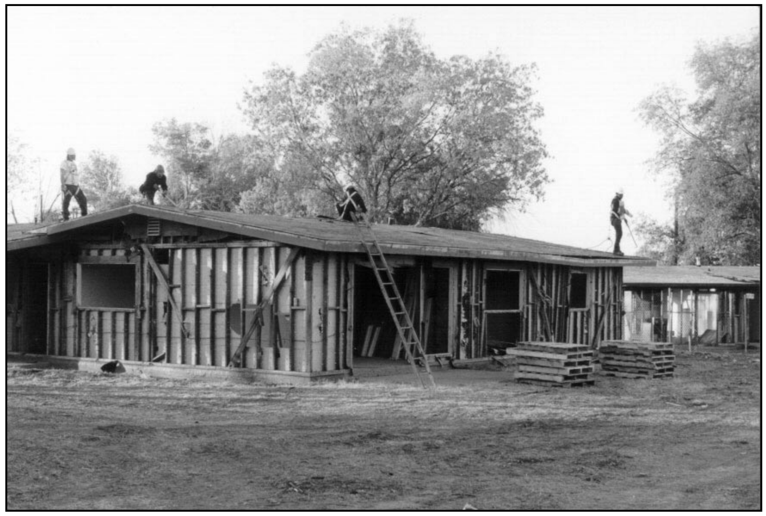
Other diseases and adverse health effects have been noted among the population exposed to asbestos fibers. Increased incidences of nonrespiratory cancers have been observed in some recent epidemiological studies. Cancers of the larynx, esophagus, stomach, colon-rectum, kidney and pancreas are present at slightly higher-than-predicted levels. An abnormality found on x-rays of persons exposed to asbestos is pleural plaque, a fibrous thickening of the lining of the chest cavity. This condition is usually not symptomatic of asbestos disease and requires no treatment. However, it tends to increase the statistical likelihood of eventually developing lung cancer. Pleural plaque is found in exposed workers as well as in family members. People living near mines, shipyards, and manufacturing plants where asbestos is utilized also experience this condition.

Synergistic Relationship Between Asbestos and Smoking: Cigarette smoking is the single most important known cause of lung cancer in humans. People who smoke 20 cigarettes per day increase their risk of developing lung cancer tenfold when compared to the nonsmoker. Workers exposed to the same level of asbestos as insulation workers historically increase their risk of developing lung cancer fivefold. These two factors working together have a synergistic effect; the smoker exposed to asbestos fibers is at least fifty times more likely to develop lung cancer.

Section 4: The Deconstruction Process

Building Survey and Action Plan

Walk and Evaluate



Deconstruction workers inspect the condition, types, and amount of salvageable materials.

An important step in assessing the feasibility of deconstruction for a structure is to conduct a detailed inventory of how the building is made and the materials it consists of. Every component, its condition, and the manner in which it is secured to the structure can have an impact on the cost-effectiveness of salvage. The condition of wood rafters or the type of mortar used or the type of nail used to fasten hardwood flooring may have no significance if a building is to be demolished. Each of the above, however, can have a profound effect on the value of the material to be salvaged and/or the labor required to recover the material.

A detailed building materials inventory includes invasive inspection of the structure, providing the opportunity to identify hazardous materials not evident during a noninvasive inspection. It is important to identify these hazardous materials because of the impact they can have on the feasibility of deconstruction. The individual(s) conducting the inventory should have construction experience and experience in identifying lead and asbestos hazards.

If a worker with the necessary experience is not available to identify hazardous materials, the project manager can consult businesses that offer these services.

The Building Materials Inventory Form (Appendix C) lists the information necessary for a baseline evaluation. In addition to completing the form, sketching a floor plan will be helpful during follow-up calculations. Depending on the size of the building, a thorough building inventory can be conducted in approximately four to eight hours. Compiling the field notes into a written report and preparing a final analysis of the feasibility of deconstructing the building will require additional time. With the inventory form completed, the quantity of material in the building can be calculated (by square foot, linear foot, board foot, weight or volume), which will help determine the salvage value of recoverable material.

Define sequence and team assignments

Once the materials inventory has been completed, the next step of the deconstruction process is to define the sequence of deconstruction based on the materials to be salvaged and the specific circumstances of the building. Every project will likely offer different sets of circumstances that may impact the process of deconstruction.

In most cases, the process of deconstruction will generally be the exact opposite of constructing a new building; structures are dismantled backward from the order in which they were built. Deconstruction can be broken down into five basic steps:

1. Remove the trim work, including door casings and molding.
2. Take out kitchen appliances, plumbing, cabinets, windows and doors.
3. Remove the floor coverings, wall covering, insulation, wiring, and plumbing pipes.
4. Disassemble the roof.
5. Dismantle the walls, frame, and flooring, one story at a time.

At the beginning of each day, the goals for each team or worker should be determined and assigned to maximize the deconstruction process. Upon completion of each of the five steps, materials should be picked up, nails removed, and materials sorted, cleaned and stacked for future reuse and transportation.

Deconstruction Safety[§§]

No formal procedures or standards exist for the structural disassembly of buildings. Without a formal procedure, it's important that the sequence of disassembly occur in a way that prevents collapse of the structure. To this end, all workers must be made aware of critical supports, both existing and temporary. Furthermore, each worker should be able to assess and understand the impact that the removal of a specific component will have on the stability of the structure or on the immediate surroundings. Workers should continually assess their actions to avoid dangerous situations.

Additional safety considerations include keeping the job site clean to avoid unsafe working conditions and maintaining communication among workers or between teams. Communication is crucial in achieving deconstruction safety. For example, if one team is working on the roof while another is inside, each team must be aware of the other's location to unsafe situations.

Deconstruction Tools and Equipment

The types of tools and equipment needed for a deconstruction project may vary depending on the task at hand. To maximize efficiency, project managers should use a checklist listing necessary tools. Using a checklist guarantee needed tools will be available and reduces the likelihood tools being lost. Tables 4, 5, and 6 list tools and equipment that are useful for various deconstruction tasks.

Table 4: Individual-Use Tools and Equipment for Deconstruction Tasks

Item	Purpose
Cats-paw	Nail removal
Flat bar	Material removal
Glove	Hand protection
Hammer	Material removal
Hard hat	Head protection
Screwdrivers – Phillips, flathead	Material removal

[§§] Deconstruction safety is the focus of Section 3.

Item	Purpose
Safety goggles	Eye protection
T-bar	Material removal
Tape measure (25-foot recommended)	Measures material
Tool belt	Holds tools
Wire cutters	Cuts electrical wires

Table 5: Site Tools and Equipment for Deconstruction Tasks

Item	Purpose
Banding Materials	Banding wood or other materials together for travel
Crimper	Crimps the clips that holds the bands together
Tensioner	Tightens the banding material
Tin snips	Cuts excess banding material
Chainsaw	Cutting through wood
Chisel	Mortar removal
Crowbar	Material removal
Extension cord	Extend power source
Fall protection equipment	Fall protection
Fire extinguisher(s)	Extinguish fires
First aid kit	Emergency first aid
Floorboard puller (custom made)	Fits over wood boards and removes them without breaking them
Generator	Power source if no power is available
Hand truck	Material transport
Ladder (6 foot, 8 foot, and extension ladders recommended)	Climbing
Masonry hammer	Mortar removal
Push broom	Cleanup
Saw horses	Workbench for denailing
Sawzall	Cutting through objects that are difficult to cut
Scoop shovel	Cleanup
Sledge hammer	Material removal
Tear-off spade	Removing roofing materials or prying wood boards
Wheelbarrow	Material transport

Table 6: Supporting Equipment for Deconstruction Tasks

Item	Purpose
Dumpsters	Trash
Flat bed truck	Material transport
Forklift	Transport and stacking of material
Storage container (large, lockable)	Storing equipment and materials
Pallets	Moving and stacking materials

Mather Military Housing Deconstruction

The deconstruction steps outlined in this manual do not address every salvageable or recyclable material, nor is every deconstruction scenario covered. The deconstruction procedures in this section come directly from the deconstruction training at the Mather military housing deconstruction site.

Trim Work, Fixtures and Fittings

The process of deconstruction generally begins in the interior of the home or building. During the initial walk-through and evaluation, a materials inventory list should be completed. This list will identify all trim work, fixtures and fittings that are to be salvaged.

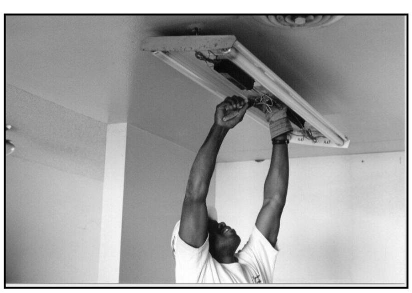
The initial step in removing any materials for salvage is to first thoroughly examine the item to be removed. The purpose is to identify how the material is attached. Knowing how the item is attached will help determine the sequence of removal, in addition to reducing the chance of damaging the material. During the removal process, each item should be continually re-examined so as not to damage the item.

Cabinet Removal

A cabinet usually consists of not only the cabinet, but the trim pieces plus the clips, nails, and/or fasteners. The first step is to remove the matching trim pieces, as these can be salvaged in addition to the cabinet. The trim pieces can be detached with a flat bar and hammer. To accomplish this, identify the locations of the nails and work the flat bar in behind the trim, taking care not to damage the cabinet or the trim piece. With the flat bar wedged in behind the trim, gently hammer the flat bar to leverage out the trim piece and to remove the nail partway from the wall. Move to the next nail, and repeat the process until the trim comes out in one piece. This approach increases the chances of removing the trim in one piece.

Workers salvage cabinets for reuse.

To remove a cabinet, first identify the nailings and remove them with a flat bar and hammer. Once the nailings have been removed, slowly and carefully pry out the cabinet a little bit at a time so you don't damage the cabinet in the process. Removing the cabinet in this manner will help to identify any additional nailings that might have been missed during the first pass.



Worker removes light fixture.

Light Fixture Removal

In addition to cabinets, light fixtures can also be salvaged and re-used depending on their condition. Before removing any light fixture, make sure all power to the fixture or home has been turned off. Next, remove the cover and identify the screws that attach the light fixture to the junction box. Remove these screws, being careful to prevent the light fixture from falling. Cautiously lower the fixture to expose the electrical wires. Cut the wires and remove the fixture.

Window Removal

A window is attached to a home via a nailing flange. This flange is covered by trim and is nailed to the wood framing. To expose the nailing flange, use a flat bar and hammer or a t-bar to remove the trim or any framing around the window. The trim work may or may not be salvageable, so keep this in mind when removing the window and the trim work.

Workers remove windows intact for reuse.

Using a flat bar, carefully wedge it behind the flange at a nailing point once the flange has been exposed. With the flat bar in place, apply pressure to the flange and the nail. This should pull the nail away from the wood. It may be necessary to hammer the flat bar to loosen the nail. Once the nail has been loosened, remove the nail.

Repeat this process until all the nails have been removed from the nailing flange of the window. Be careful to support the window when the last few nails are removed. The final step is to carefully remove the window. Removal larger windows may require two people.

Door Removal

Several door components can be salvaged, including jambs, casings, trim, and hardware. To remove a door, first locate the hinges that keep the door attached to the wall. Remove the hinge pins using a screwdriver and, if necessary, a hammer. With the hinge pins out, carefully remove the door from the frame and set it aside. Next remove the screws holding the hinges to the wall, using a Phillips head screwdriver.

To remove jambs, casings, and trim, first identify the locations of the nails and work the flat bar in behind the material, taking care not to damage it. With the flat bar wedged behind the material, apply pressure to the flat bar to leverage out the material and to remove the nail partway from the wall. Use a hammer if necessary. Move on to the next nail and repeat the process until the material can be removed as one piece. Finish nails may come out with the material. This is not a problem because the goal is to salvage the wood, but these nails should be removed, as a safety precaution.

Other types of doors that can be salvaged include glass doors, French doors, closet doors, and rollup garage doors.

Floor Coverings

The materials inventory sheet should note which floor materials are to be deconstructed. Tile can be removed with a masonry hammer and chisel. The first step in removing tile is to break up the surrounding grout before prying out the tile. Once the surrounding grout has been broken up, wedge a chisel or flat bar underneath the tile and carefully pry the tile out from the grout.

Carpet can be salvaged and resold if it is in good condition. A problem with carpet, though, is that it has been cut to match the room in which it was installed, so it can only be reused in a room of smaller size. Baseboards and trim work can also be salvaged and reused.

To remove baseboards and trim, first identify the locations of the nails and work the flat bar in behind the material, taking care not to damage it. With the flat bar wedged behind the material, apply pressure to the flat bar to leverage out the material and to remove the nail partway from the wall. Use a hammer if necessary. Move to the next nail and repeat the process until the material can be removed as one piece. Finish nails may come out with the material. This is not a problem because the goal is to salvage the wood, but these nails should be removed, as a safety precaution.

Hardwood floors may be salvaged, but problems may arise if the floors are securely glued.

Other Salvageable Items

In addition to the materials listed above, there are many other materials that may be salvaged if they are in good condition. Table 7 provides a partial list of these items.

Table 7: Salvageable Items

Salvageable Items	Notes
Sinks	Pedestal sinks
Stoves	Ranges, ovens, cooktops
Countertops	Formica or other laminate Stone (e.g., marble or granite)
Plumbing	Faucets and fixtures Copper Lead and cast iron, brass Porcelain fixtures (can be rehabilitated)
Mirrors	In good condition

Roof dismantler uses a fall restraint system while deconstructing a roof.

Roof Deconstruction

The first step in deconstructing a roof is to remove the roofing materials. The types of roofing materials vary widely and may or may not be salvageable. For example, concrete tile or clay tile can be reused if not broken. Other types of materials that can be found include slate, copper, vents and flashing, and sheet metal. If the materials cannot be reused, they may be recyclable.

When on the roof, workers should use a fall restraint system (Section 3 discusses safety and fall protection). Always be aware of your position on the roof; once the rafters are exposed, use them to support your weight to avoid falling through the drywall.

The roofs of the military housing at Mather Air Force Base were covered with a layer of rock, followed by roofing felt underneath, and then wood boards as the bottom layer. The first step was to remove the rock with a shovel. Once the rock was removed, a tear-off spade was used to loosen the roofing felt, sections at a time. After a section of roofing felt was detached, the remainder was pulled off manually.

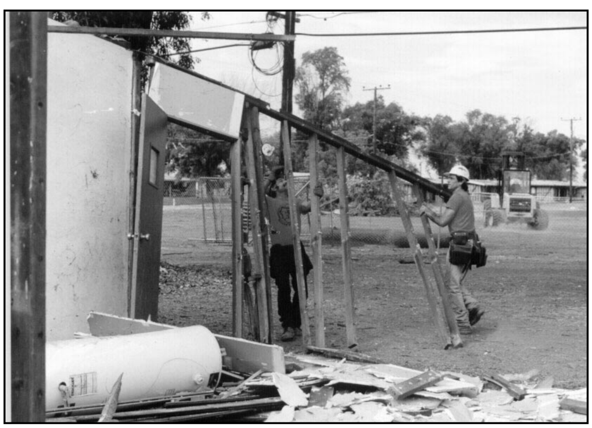
Workers used a board puller to remove the wood portion of the roof. In most cases, wood boards are reusable, so care should be taken to remove them without splitting or breaking them apart. Removal of the wood boards starts at the peak of the roof and moves down toward the edge of the roof.

As each board is removed, orient the board vertically and lower one end to the ground while resting the other end against the roof edge. This will give the denailing team access to the boards.

Roof dismantler uses a board puller to remove wood boards.

Once the wood boards have been removed, the next step is to take out the rafters. Using a hammer, remove the blocking between the rafters. Next, use the t-bar to pry up the rafter , starting at the top plate. Continue this process until all the rafters have been removed.

At the roof edge, remove any gutters and downspouts. Aluminum and steel gutters and downspouts are recyclable. The final step is to collect and denail the wood.



Dismantlers remove interior walls.

Wall Deconstruction

The process of deconstructing a wall assembly is almost the exact opposite of constructing the wall.

Interior Walls

Starting from the interior of the home, use a hammer to knock out the drywall and expose the framing. Older homes may use plaster rather than drywall. The framing material will most likely be wood. Insulation and fire blocks may be between the framing members. Remove the insulation. There may also be cross bracing. Once the framing has been exposed, move to the exterior wall.

Wall deconstruction should begin at the interior of the home and end at the exterior. Once the fire blocks and cross bracings are removed, the structural integrity of the wall will be compromised. This can pose a serious safety hazard. Therefore, great care should be exercised when deconstructing the walls.

Exterior Walls

Remove any siding or masonry from the building's exterior. Stone and masonry can be reused. Siding may be recyclable. Next, remove any building paper, plywood, or foam board. Then knock out the fire blocks with a hammer. Finally, remove the vertical studs and top plates. It may be more convenient to pull sections of the wall down and then remove individual studs.

Floor Deconstruction

Floor deconstruction should be one of the final steps in the deconstruction process. Floor deconstruction needs to be distinguished from removal or salvage of the floor coverings. Salvage of the floor coverings occurs earlier in the deconstruction process so that the salvageable materials are not damaged during other phases of the process (see “Floor Coverings” in this section).

If the floor type is slab-on-grade, no further deconstruction is required. If the floor is a raised floor, additional materials can be salvaged, including floor joists, beams, girders, and plywood. Tongue and grooved dimension lumber is highly salvageable.

Denailing and Banding

At each step of the deconstruction process, pick up the materials, remove any nails, and sort, clean, and stack materials for future reuse. This serves two important objectives—it keeps the job site as clean as possible and helps avoid unsafe working conditions.

Nails must be removed from all wood boards before the boards are stacked and banded. It is a good idea to designate a specific area for this task, reducing proliferation of nails throughout the deconstruction site. This plan also accelerates stacking and banding of wood. Once a board has been de-nailed using a hammer or cats-paw, the wood should be stacked onto crates. Use of crates elevates the wood above the ground so that the stacked wood can be banded together easily and then moved by a forklift for placement onto a truck for transportation.

Denailing and banding process: *Left*–Worker removes nails from wood board. *Center*–Staging area for denailing and banding activities. *Right*–Worker stacks wood boards and secures the stack with bands.

Appendix A: Fall Protection

Fall Protection Equipment Inspection

Harnesses, body belts, safety straps, and lanyards shall be inspected each day before each use to determine they are safe. Those determined to be unsafe shall immediately be removed from service. One worker should inspect harnesses, body belts, safety straps, and lanyards once every six months and document the results. This person should be able to identify existing and predictable hazards in the surroundings or unsanitary, hazardous, or dangerous conditions. This person should also have authorization to take prompt corrective measures to eliminate these conditions.

This appendix contains an equipment inspection form to prevent falls. Users of this manual may make as many copies as necessary.

Hazard Evaluation/Code of Safe Practices

When there is a hazard, there must be a code of safe practices or a safety rule. There should be a safety meeting at least every 10 days, as required by OSHA.

This appendix contains a form for hazard evaluation and a code of safe practices for general work areas and specific job safety classes. The form should be updated as necessary and should be made available to all employees involved in the use of fall protection equipment.

Disclaimer

The materials and information provided are not meant to be comprehensive but instead only offer a starting point for a safety program. A comprehensive safety program should be developed and tailored to the specific needs of the company and the job task and meet all the requirements (if any) of the appropriate state, federal, or other agency (ies).

Although the information in this guide is believed to accurately represent the current state of the art, neither ConSol, nor California Integrated Waste Management Board, nor Kaufman and Broad, nor Sacramento Housing and Redevelopment Agency nor any of their employees or representatives makes any warranty, express or implied, with respect to the accuracy, effectiveness, or usefulness of any information, method, or material in this guide, nor assumes any liability for the use of any information, methods, or materials disclosed herein, or for the damages arising from such use.

Fall Protection Equipment Inspection Form

Equipment Inspected: ______________________________

Date: ______________

Inspected by: ______________________________

Full-Body Harness/Positioning Belt/Body Belt Inspection

1. Belts and straps: Check for frayed edges, broken fibers, pulled stitches, cuts, or chemical damage.
2. D rings: Check D ring and D ring metal wear pad (if any) for distortion, cracks, breaks, and rough or sharp edges.
3. Attachments of buckles: Note any unusual wear, frayed or cut fibers, or distortion of buckles/D rings. Check all rivets.
4. Frayed or broken strands: Check webbing surface for broken/cut stitches.
5. Tongue or billet: Inspect for loose, distorted, or broken grommets.
6. Tongue buckle: Check for distortion or sharp edges.
7. Friction buckle: Outer bars and center bars must be straight. Check corners and attachments points of the center bar.

Lanyard Inspection

1. Hardware:
2. Snaps: Inspect for hook and eye distortions, cracks, corrosion or pitted surfaces. Inspect latch and keeper spring/lock.
3. Thimbles: Edges of thimble must be free of sharp edges, distortions or cracks.
4. Steel lanyard: Check for cuts, frayed areas or unusual wear patterns.
5. Web lanyards: Check for swelling, discoloration, cracks, and charring from heat/chemical damage.
6. Rope lanyard: Check for fuzzy, worn, broken, or cut fibers.

Findings/Recommendations

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Hazard Evaluation and Code of Safe Practices for General Work Areas and Specific Job Safety Classes

General Area of Specific Job Safety Class:____

Date Prepared:____

Prepared By: ____

Description of Job/Task	Potential Safety/Health Hazards	Code of Safe Practices
	Falls due to improper fall protection equipment.	Employees will only use fall protection equipment that is approved for the task.
	Falls due to improper use of fall protection equipment.	Employees will follow all safety rules/guidelines established by the company with respect to the use of fall protection equipment.
	Falls due to the use of fall protection equipment that is frayed, distorted, cracked or cut.	Employees are to inspect all fall protection equipment for damage prior to each use.
	Falls due to the use of improper tie-off points.	Employees using fall protection equipment must tie off only at approved points.
	Injuries/falls due as a result of slipping on wet surfaces.	Employees will only wear approved footwear and use caution when working on wet surfaces.
	Injuries/falls due to slip/trip hazards	Employees will keep worksite clean and orderly. All equipment will be properly stored when not in use.

Appendix B: Forklift Operation

Forklift Operating Rules

OSHA requires that operating rules governing forklift operation be posted at the job site. A poster containing operating rules for industrial trucks may be ordered or downloaded through Cal/OSHA's publications page (www.dir.ca.gov/DOSH/puborder.asp). If Internet access is not available, the Cal/OSHA Education Unit at (916) 574-2528 can fax callers a request order form to use in ordering hard copies.

Forklift Pre-Operation Checklist

Cal/OSHA requires that each forklift be inspected every day before use. Generally, the first person to use the forklift is responsible to inspect it. The forklift operator's daily report must be filled out each day.

This appendix also provides a checklist to use before forklift operation. The list must be gone through daily.

Forklift Pre-Operational Checklist

Model: ____________________

Serial Number: ____________________

Pre-Operation Inspection***	**Sun**	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
Date							
Battery water/vent caps							
Battery connectors							
Check for leaks							
Tires and wheels							
Carriage							
Forks							
Mast							
Lights							
Horn							
Cage and seat							
Fire extinguisher							
Parking brake and alarm							
Brake operation							
Hydraulic controls							
Speed and direction controls							
Steering controls							

Report any problems and/or unsafe conditions to department supervisor when discovered. All lift trucks are to be inspected daily before use.

Additional Comments:	**Problem(s) Reported To**

*** Operator must initial after checking off each item in “Pre-Operation Inspection” section.

Appendix C: Building Materials Inventory

A detailed building materials inventory includes invasive inspection of the structure, providing the opportunity to identify hazardous materials not evident during a noninvasive inspection. It is important to identify these hazardous materials because of the impact they can have on the feasibility of deconstruction. The individual(s) conducting the inventory should have construction experience and experience in identifying lead and asbestos hazards.

If a worker with the necessary experience is not available to identify hazardous materials, the project manager can turn to businesses that offer these services.

The Building Materials Inventory Form lists the information necessary for a baseline evaluation. In addition to completing the form, sketching a floor plan will be helpful during follow-up calculations. Depending on the size of the building, a thorough building inventory can be conducted in approximately four to eight hours. Compiling the field notes into a written report and preparing a final analysis of the feasibility of deconstructing the building will require additional time. With the inventory form completed, the quantity of material in the building can be calculated (by square foot, linear foot, board foot, weight or volume), which will help determine the salvage value of recoverable material.

This appendix contains a copy of the Building Materials Inventory Form.

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The materials and information provided are not meant to be comprehensive but instead only offer a starting point for a safety program. A comprehensive safety program should be developed and tailored to the specific needs of the company and the job task and meet all the requirements (if any) of the appropriate state, federal, or other agency (ies).

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Building Materials Inventory Form

Building Inspection Information

Building Identification: ______________________________

Date: ______________________________

Inspected by: ______________________________

Roof System			
Wood framing	Roof type (gable, hip, mansard, etc.):		Pitch:
	Roofing material:		No. of layers:
	Rafter:	Size:	Length:
	Ridge beam:	Size:	Length:
	Spacing of framing members:		
	Sheathing type (tongue and groove, butt joint):	Size:	
	Ceiling joists	Size:	Length:
Exterior Wall System			
Masonry	Width (single or double wythe, cavity, etc.):		
	Location of rebar:		
	Steel lintels:		
Wood framing	Stud:	Size:	Height:
	Plate Top: Bottom:	Size:	Length:
	Spacing of framing members:		
	Sheathing type:	Size:	Length:
Floor System			
Wood framing	Joist:	Size:	Length:
	Spacing of framing members:		
	Center carrying beam for joists:	Size:	Length:
	Sheathing/subfloor type:		

Notes			
Interior Walls: Wood Framing			
Load-bearing walls	Stud:	Size:	Height:
	Plate: Top: Bottom:	Size:	Length:
	Spacing of framing members:		
	Total linear feet of wall:		
Partition walls	Stud:	Size:	Height:
	Plate Top: Bottom:	Size:	Length:
	Spacing of framing members:		
	Total linear feet of wall:		
Foundation: Masonry			
	Type (block, poured):	Width:	Height:
	Location of rebar:		
	Slab:	Thickness:	Rebar:
	Chimney type (solid, lined):		Size:
	Sump pump:		
Fascia/Eave			
	Fascia:		
	Rake:		
	Gutters:		

Connections between building elements (anchor bolts, strapping, hold downs, etc.)	
	Floor/wall:
	Wall/roof:
	Window/wall:

Finish Materials			
	Plaster/lath:		Ceiling height:
	Finish flooring (type):	Fastening:	
	Unpainted wood (type):	Linear feet:	
	Cabinets (type):		
	Stair treads (type):	Number:	Width:
	Shelving (type):		
	Plumbing fixtures (type):		
	Appliances (type):		

Notes

Heating System			
	System (type):		
	Boiler/furnace:		
	Hot water heater:		
	Radiators:		
Other			
	Doors (type):		Size:
	Windows (type):		Size:
	Metals: Piping for plumbing, domestic hot water, etc.:		
Miscellaneous			
	Extent of rot:		
	Lumber grading stamp:		
	Overall building dimensions:		
	Date of construction (approx.):		
	Complicating site conditions: Steep grade, trees near the building:		
Notes			

Floor Plan Sketch

Appendix D: References

Internet Sources

National Association of Home Builders Research Center: www.nahbrc.org/

Smart Growth Network: www.smartgrowth.org/

California Trade and Commerce Agency page on California military base closures and the current status of reuse efforts: www.cedar.ca.gov/military/current_reuse/mather.htm - mather_anchor

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Information from companies directly involved with the deconstruction at Mather Field.